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Topic of Research: Synthesis, characterization and application of multifunctional organic-inorganic hybrid composite materials for water treatment.

Findings

The thesis consists of the six chapters. Chapter 1, entitled "Introduction and Literature review" deals with the brief introduction of water pollutions, dye contaminations, water treatment technologies and adsorption process. Chapter 2, entitled "Material and methods" comprises the synthesis of composites, detailed methodology adopted, instrumentation involved in the analysis of physio-chemical properties of the prepared composites. Chapter 3, entitled "Synthesis, characterization and application of *Alysicarpus vaginalis* based hybrid nanocomposite: Fe_2O_3-ZrO_2/AV" . It discusses low-cost organic-inorganic hybrid nanocomposite has been synthesized by incorporating Fe_2O_3-ZrO_2 into organic framework of medicinal plant *Alysicarpus vaginalis,* AV, material, referred to as Fe_2O_3-ZrO_2/AV. The composite has been characterized and investigated for wastewater treatment through adsorption and photodegradation to eliminate Methylene blue dye. The composite has adsorbed Methylene blue from simulated water and process parameters were optimized at dosage 3.0 g L^{-1}, dye concentration 10 mg L^{-1}, pH 7, 30^oC temperature, and contact time 120 min. The sorption capacity of nanocomposite was found to be 13.00 mg/g. The process was found exothermic and feasible at temperature range 30-50^oC and concentration range 5-30 mg L^{-1} of the dye. The kinetics investigation suggested sorption as pseudo-second order controlled process directed by particle diffusion step. The sorption data fitted well the Temkin isotherm. The Fe_2O_3-ZrO_2/AV has band gap of 3.11 eV and therefore, could perform photocatalytic degradation of Methylene blue in solution. Moreover, nanocomposite was also screened for antioxidant activity and proved successful. Chapter 4, entitled "Synthesis, characterization and application

of *Alysicarpus vaginalis* based hybrid nanocomposite: $MnFe_2O_4$/AV". It dicusses the preparation, morphology, surface area of Fe_2O_3-ZrO_2/AV have been investigated. The application of Fe_2O_3-ZrO_2/AV for Methylene blue removal has also been observed under the effects of various parameters. The antioxidant activity of the prepared composite has been also studied. Further, the photocatalytic ability to degrade Methylene blue dye has also discussed. To understand the process of adsorption various isotherm and kinetic models, along with the thermodynamic parameters have been discussed. Chapter 5, entitled "Synthesis, characterization and application of *Alysicarpus vaginalis* based hybrid nanocomposite: $MgFe_2O_4$/AV". The present study aims to remove Nile blue dye from water by process of adsorption using *Alysicarpus vaginalis* plant-based hybrid multifunctional nanocomposite. The maximum adsorption capacity has been found to be 28.63 mgg^{-1}. The process of adsorption under study has been found as feasible and exothermic in nature. The pseudo second order kinetic model was found best suited for the adsorption process. The Freundlich isotherm was found to be followed by the adsorption process. Thus, $MgFe_2O_4$/AV composite proves to be economical, easy to synthesise, eco friendly and antioxidant material for water treatment process. Chapter 6, entitled "Synthesis, characterization and application of *Alysicarpus vaginalis* based hybrid nanocomposite: Fe_3O_4/AV". Cost effective organic-inorganic hybrid nanocomposite has been synthesised by the incorporation of Fe_3O_4 on the organic framework of Alysicarpus vaginalis plant material. The composite could easily adsorb Congo Red dye from wastewater. The maximum adsorption capacity was found to be 26.93 mg g^{-1}. The adsorption process was found to be feasible and endothermic in nature. The adsorption process followed pseudo second order kinetics with particle diffusion as the rate determining step. Also, Freundlich isotherm is found to be suitable for the adsorption process. The prepared adsorbent also shows good antioxidant activity.